YEAST AND MOLD COUNTS AS AN INDEX TO THE EFFICIENCY OF PASTEURIZATION OF CREAM FOR BUTTER MAKING PURPOSES

BY

BENJAMIN ANDREW STIRITZ

B. S. University of Illinois, 1918

THESIS

Submitted in Partial Fulfillment of the Requirements for the

Degree of

MASTER OF SCIENCE

IN DAIRY HUSBANDRY

IN

THE GRADUATE SCHOOL

OF THE

UNIVERSITY OF ILLINOIS

1922

UNIVERSITY OF ILLINOIS

THE GRADUATE SCHOOL

January 27 1922

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY BENJAMIN ANDREW STIRITZ.

ENTITLED YEAST AND MOLD COUNTS AS AN INDEX TO THE EFFICIENCY OF PASTEURIZATION OF CREAM FOR BUTTER MAKING PURPOSES.

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN DAIRY HUSBANDRY.

M. J. Prucha
In Charge of Thesis

H. A. Ruehe
Head of Department

Recommendation concurred in*

Committee
on
Final Examination*

*Required for doctor's degree but not for master's

Acknowledgment.

The author wishes to take this opportunity to express his appreciation for the suggestions and supervision he has received from Dr. H. A. Ruehe and from Dr. M. J. Prucha.

Table of Contents.

YEAST AND MOLD COUNTS AS AN INDEX TO THE EFFICIENCY OF PASTEURIZATION OF CREAM FOR BUTTER MAKING PURPOSES.

I. Introduction.

The yeast and mold content of finished butter is considered by some men[1] who are engaged in dairy work as an index to the efficiency of pasteurization of cream for butter making purposes and to the proper handling of cream after this important process is completed. The laboratory of "The American Association of Creamery Butter Manufacturers" uses the yeast and mold count as an index to efficiency. They assume that, when samples of butter show a low count, the product has been manufactured efficiently. From the biological standpoint, it has been found that in plants[2], producing butter with a high yeast and mold count, lax methods of pasteurization and handling of cream prevail. In such plants, the counts were lowered materially, in the finished products, by improving the process of manufacture in regard to careful pasteurization and handling of cream.

There is little published data on yeasts and molds in creamery butter. Mr. T. H. Lund of Ontario Agricultural College, Guelph, Ontario, Canada, has shown that the yeast and mold count in butter is influenced by efficient pasteurization and he has suggested that such a count be adopted officially in determining whether butter is made from raw or from pasteurized cream. Lund has

---

1 Mr. F. W. Bouska and Mr. J. C. Brown (9) and Mr. T. H. Lund (4,5,6,7,8).

2 The plants are operated by members of "The American Association of Creamery Butter Manufacturers" and are located in various communities according to a personal interview which the author had with Mr. F. W. Bouska.

pointed out also, that even though the pasteurization process may be efficient, the cream can be contaminated in the subsequent handling by the use of yeast and mold infected churns or other equipment (5,6,8).

The yeasts and molds, that are found in butter, include a variety of yeasts (not isolated individually), but the molds are mainly Oidia (lactis)(9).

Mr. F. W. Bouska has set the arbitrary standard of 30 as the maximum count of yeasts and molds in butter which has been made from efficiently pasteurized cream. However, a large percentage of the counts should be 10 or less (9).

Few, if any, yeasts and molds or their spores can survive a temperature exposure of 145°F. for 30 minutes or 185°F. for 30 seconds. Such temperature exposures are those used ordinarily in pasteurizing cream for butter making. Both Dougherty (1) and Wells (2) have demonstrated that most yeasts are destroyed at a temperature of 61°C. (141.8°F.). Dougherty found only three yeasts which survived this temperature. Thom and Ayers (10) have shown that few mold spores in milk survive a temperature of 60°C. (140°F.) for 30 minutes and still less are able to withstand 62.8°C. (145°F.) for 30 minutes. Only three species of Aspergillus survived 62.8°C. for 30 minutes.

O. F. Hunziker (3) summarizes the efficiency of pasteurization in destroying yeasts and molds in butter. By his investigation, he showed that the efficiency of pasteurization in killing yeasts and molds was 78 per cent when a temperature exposure of 165°F. for 30 seconds was used, while at 185°F. for 30 seconds or 145°F. for 30 minutes (the latter two being the methods ordinarily used in creameries), the process was 99.9 per cent efficient.

II. Object.

The purpose of this investigation was two fold: first, to determine whether or not the yeast and mold count could be taken as an efficiency index to pasteurization and handling of cream for butter making purposes; and second, to determine the source of contamination when butter made from pasteurized cream has a high yeast and mold count.

III. Method of Procedure.

(a) Nutritive agar.

In making the various counts of all organisms (bacteria, molds and yeasts), ordinary nutritive agar was used. This medium was made up as follows: 15 grams of shredded agar, 10 grams of "Difco" standardized bacto-peptone and 5 grams of Liebig's beef extract in 1 litre of distilled water.

(b) Whey agar.

During the first five months of the investigation, whey agar was used as a medium for determining the yeast and mold counts. The whey agar was prepared as follows: 15 grams of shredded agar and 10 grams of "Difco" standardized bacto-peptone in 1 litre of whey. The whey was secured by adding 1 cubic centimeter of rennet extract (diluted to 40 cubic centimeters with cold water) to a gallon of skimmed milk, and after the coagulation was completed, the curd was filtered off through a double thickness of cheese cloth.

Approximately 10 cubic centimeters of the above medium was used for each petri dish, and to this 1 cubic centimeter of a sterile 1 per cent tartaric acid solution was added for the purpose of inhibiting the growth of all organisms other than yeasts and molds. However, it is possible that some Bulgaricus bacteria may grow on such medium.

(c) "Malt" agar.

Later in the investigation, medium made from ordinary malt drinks (often sold under the name of "near beer") was found to be more satisfactory for yeast and mold growth than the whey agar. The "malt" agar was made as follows: 15 grams of shredded agar was added to 400 cubic centimeters of the malt drink and 600 cubic centimeters of distilled water. This was heated to boiling and held at this temperature until the agar was dissolved. The medium was acidified

just previous to pouring the plates by mixing 4 cubic centimeters of a sterile 5 per cent solution of lactic acid with 100 cubic centimeters of "malt" agar. This acidity was sufficient to inhibit the growth of organisms other than yeasts and molds. This medium was similar to that used by Mr. T. H. Lund, but varied in one of its ingredients. The agar prepared by Mr. Lund contained brewery wort (8), while in this investigation, brewery wort was not obtainable and the malt drink was substituted for it.

For each plate, 1 cubic centimeter of cream, buttermilk, starter or water was measured into a petri dish by means of a sterile 1 cubic centimeter pipette. Then sufficient agar -- either nutritive or "malt" agar depending on whether a total bacterial count or a yeast and mold count was to be made -- was added to cover the bottom of the dish. The agar was poured at a temperature of 45°C. so that it would flow, and yet not be so hot as to kill any of the organisms. The dish was moved in a rotary motion so as to mix the agar and the sample thoroughly. In the case of the butter, it was melted to the constituency of thick cream and 1 cubic centimeter was used for each count. The same method was followed in preparing plates of the butter as was used for plating the cream, buttermilk, starter and water.

The most rapid and luxurious growth of yeasts and molds was obtained by incubating the plates at 30°C. for a period of five days, while the plates for the total counts were held at 37°C. for three days.

To obtain as complete data as possible, counts were run on butter which was made from both pasteurized and raw cream. In order to determine the total count and also the number of yeast and mold colonies, every step in the butter making process was plated. In the case of the butter made from unpasteurized cream, counts were made on raw cream and butter. In the case of pasteurized cream, plates were made from raw cream, pasteurized cream, ripened cream, butter, buttermilk and starter.

The sample of the raw cream was taken from the vat just previous to pasteurization. After the entire volume of cream was pasteurized, the cream in the vat was agitated and a sample was taken for plating. After pasteurization, the cream was cooled to 70°F. and 10 per cent starter was added. It was held at this temperature for one and one half to two hours and then the cream was cooled to the churning temperature and held over night. A sample of this ripened cream was taken just previous to churning. When the churning was completed and the butter worked, a representative sample (some butter from various parts of the churn) was taken and the plates were made. The sample of buttermilk was drawn from the gate of the churn immediately after the butter granules had gathered. In the case of the starter, the sample was taken after the starter was mixed thoroughly by stirring and previous to its addition to the pasteurized cream. All of the above liquid samples were taken by using a 100 cubic centimeter pipette. A sterile spoon was used for sampling the butter. The samples were placed in a sterile, ground glass stoppered bottle of 250 cubic centimeters capacity. If the plating was not done immediately, the samples were held in the ice chest until the plates could be poured.

For the purpose of checking up on the influence of yeast and mold infected churns, the following procedure was carried out with three large churns (600 and 1000 pounds capacity) of the type used in commerical creameries and one small, power churn (75 pounds capacity). In the case of the large churns, twenty gallons of boiled water were put in the churn and it was revolved in fast gear for five minutes. The same method was used in rinsing the small churn except that five gallons of boiled water were used. In each case, a sample of the boiled water was plated to obtain a count, so that the increase in the microörganism content of the water after rinsing could be taken as the increase due to yeast and mold infected churns.

Plates were made from samples of starter secured from various creameries in the State of Illinois to determine the influence of average starters as a source of contamination in pasteurized cream. Total counts and yeast and mold determinations were made on each sample. An acidity test was made on each sample of starter by the following method. The starter was mixed thoroughly and 17.5 cubic centimeters (approximately 18 grams) were transferred to a white cup using a 17.6 cubic centimeter pipette. The pipette was rinsed with 17.6 cubic centimeters of distilled water and the rinse water was added to the cup containing the starter. Four to six drops of phenolphthalein (prepared by adding 30 grams of powdered phenolphthalein to 300 cubic centimeters of 50 per cent alcohol)were added as an indicator. A tenth normal solution of sodium hydroxide was use to titrate the acid in the starter. The alkali was added, drop by drop, from a 25 cubic centimeter burette until a faint pink color appeared and remained for 30 seconds. The amount of alkali necessary to neutralize the acid in the starter was determined by the reading of the burette. The acidity of the starter was calculated as lactic acid by the following formula:

$$\text{per cent acidity} = \frac{\text{c.c. of N/10 alkali used} \times .009}{\text{weight of starter}} \times 100$$

The factor, .009, is the acid equivalent of a tenth normal solution of sodium hydroxide. One cubic centimeter of a tenth normal alkali will neutralize .009 grams of lactic acid. This is the meaning of the term, acid equivalent.

Table I. Bacterial Counts in Butter - Total Counts.*

Date	Raw Cream	Pasteurized Cream	Ripened Cream	Butter	Buttermilk	Starter
10-22	37,000,000	5,700	32,000	78,000		-----------
10-25	146,000,000	19,000	1,125,000	5,000		156,000,000
11-12	77,000,000	19,750	7,000,000	43,350		206,000,000
11-18	98,000,000	3,725	17,500,000	97,000		37,500,000
11-22	43,000,000	12,500	253,000	56,200		16,250,000
12-3	41,000,000	------	40,000	18,000		-----------
12-13	12,750,000	2,500	15,500,000	34,500		-----------
12-20	15,050,000	4,000	----------	16,000		-----------
12-25	157,500,000	44,500	----------	31,500		-----------
12-27	59,000,000	83,000	----------	12,000		-----------
1-5	106,500,000	8,150	350,000	11,150	106,500	-----------
1-14	300,000,000	105,000	----------	10,550	8,000,000	900,000,000
3-14	17,500,000	6,150	2,500,000	16,700	6,500,000	250,000,000
3-18	136,500,000	2,300	----------	8,850	---------	-----------
4-1	58,000,000	------	2,500,000	46,500	7,500,000	166,500,000
4-11	8,500,000	1,350	1,185,000	89,000	2,000,000	202,000,000
4-25	400,000,000	143,500	----------	10,350	---------	-----------
5-9	950,000,000	2,350,000	37,000,000	5,775,000	60,500,000	268,000,000
5-17	78,000,000	33,000	----------	70,000	3,000,000	-----------
6-27	120,500,000	51,750	400,000,000	3,245,000	298,000,000	1,550,000
7-8	350,000,000	60,000	----------	30,000	605,000	-----------
7-18	800,000,000	150,000	----------	29,450	9,000,000	-----------
7-21	800,000,000	850,000	13,000,000	110,000	11,500,000	47,000,000
7-28	650,000,000	115,000	11,500,000	110,000	18,500,000	331,000,000
8-1	145,000,000	25,000	42,100	7,900	350,000,000	84,250,000

* Counts are the averages of two, three or four plates and are the number of bacteria per one cubic centimeter.

Table I. Bacterial Counts in Butter - Yeasts and Molds (continued).*

Date	Raw Cream	Pasteurized Cream	Ripened Cream	Butter	Buttermilk	Starter	Pasteurization Efficiencies		Per cent Decrease from the Raw Cream to the Butter	
							Total Count	Yeasts & Molds	Total Count	Yeasts and Molds
10-22	105,000	40	90	15	----	--------	99.98	99.96	99.79	99.98
10-25	850,000	110	1,060	79	----	1,506	99.98	99.98	99.99	99.99
11-12	125,000	19	20	15	----	20	99.87	99.98	99.86	99.99
11-18	2,510,000	35	44	30	----	12	99.99	99.99	99.90	99.98
11-22	436,000	14	65	20	----	49	99.97	99.98	99.86	99.99
12-3	380,000	---	21	24	----	--------	-----	-----	99.95	99.95
12-13	4,200	4½	20	10	----	--------	99.99	99.88	99.98	99.76
12-20	26,000	20½	--	10	----	--------	99.98	99.89	99.97	99.94
12-25	17,500	8½	--	5	----	--------	99.98	99.94	99.98	99.97
12-27	36,500	13	--	6	----	--------	99.86	99.96	99.98	99.98
1-5	98,000	19	22	8	33	--------	99.99	99.98	99.88	99.99
1-14	170,000	10	--	4	26	0	99.99	99.99	99.95	99.99
3-14	130,000	5	45	7	31	1,150	99.99	99.99	99.90	99.99
3-18	10,250	8	--	1½	----	--------	99.99	99.93	99.99	99.99
4-1	170,000	---	24	15	48	3½	-----	-----	99.92	99.99
4-11	68,500	3	8	0	16	0	99.99	99.99	98.95	100.00
4-25	14,350	9	--	3½	----	--------	99.96	99.93	99.99	99.99
5-9	11,200	2½	27	24	61	0	99.73	99.97	98.34	99.78
5-17	2,850	2	--	42½	97	--------	99.95	99.93	99.90	98.49
6-27	17,350	1½	1	250	7,900	0	99.95	99.99	97.30	98.57
7-8	40,000	2	--	30	118	--------	99.98	99.99	99.99	99.92
7-18	70,000	67	--	18	80	--------	99.98	99.93	99.99	99.98
7-21	115,000	110	1,000	42	1,200	2,150	99.88	99.90	99.98	99.96
7-28	455,000	20	29	7	30	1	99.98	99.99	99.99	99.99
8-1	65,000	12½	13	18	89	0	99.99	99.99	99.99	99.99

* Counts are the averages of two, three or four plates and are the number of organisms per one cubic centimeter.

Table II. Bacterial Counts of the Churn Rinsings.[1]

Date	Churn	Size of Churn	Total Counts		Yeasts		Molds		Increase due to Churn			Amount of Rinse Water Used (in gallons)
			Check on Water	No. Bacteria in Rinse Water	Check on Water	No. Yeasts in Rinse Water	Check on Water	No. Molds in Rinse Water	Total Counts	Yeasts	Molds	
3-28	A	600#	272	29,000,000	0	144*	0	---	28,999,728	144*	---	20
2-24	A	600#	306	69,000,000	0	6	0	36	69,499,694	6	36	20
2-24	B	75#	306	80,000,000	0	10,650*	0	---	79,999,694	10,650*	---	5
3-4	C	1000#	2,300	160,000,000	0	3	0	1.5	159,997,700	3½	1½	20
3-4	D	1000#	2,300	140,000,000	0	2	0	1.5	140,247,700	2	1½	20
3-24	A	600#	2,950	7,500,000	0	1	0	1.5	7,497,050	½	1½	20
3-24	B	75#	2,950	550,000,000	0	0	0	350	549,997,050	0	350	5
3-25	C	1000#	1,375	10,500,000	0	½	0	3	10,498,625	½	3	20
4-20	A	600#	250	300,000,000	0	33	0.5	0.5	299,999,750	33	0	20
4-20	B	75#	250	650,000,000	0	1,050	0.5	500	649,999,750	1,050	499½	5
4-28	A	600#	900	9,000,000	0	35	0	34	8,999,100	35	34	20
4-28	B	75#	900	25,000,000	0	19	0	31	24,999,100	19	31	5
6-24	A	600#	65000	4,500,000	0.5	10	1	1.5	4,435,000	9½	½	20
6-24	B	75#	65000	10,500,000	0.5	5,000	1	4,500	10,435,000	4,999½	4999½	5

[1] Counts are the averages of two, three or four plates and are the number of organisms found in one cubic centimeter.

* Yeast and Mold Counts combined.

Table III. Bacterial Counts in Samples of Starter.[1]

Date	Source	Total Counts	Yeasts	Molds	Acidity of Starter
1-17	A	37,000,000	0	0	.75%
2-21	B	270,000,000	0.5	7	.73%
2-21	C	395,000,000	0	0	.71%
2-21	C	267,000,000	0	0.5	.79%
2-21	D	27,000,000	0	1	.81%
2-21	D	13,000,000	0	6	.83%
2-21	D*	250,000,000	1	0.5	.78%
3-1	C	64,250,000	3	3	----
3-1	C	36,500,000	14	17	----
3-4	D	42,500,000	0	6.5	.70%
3-4	D	65,500,000	0	2.5	.78%
3-16	E	220,000,000	3	0.5	.78%
3-16	F	250,000,000	8	1	.89%
3-24	C	135,333,333	0	0	.72%
3-24	C	50,000,000	4.5	22	.86%
3-24	C	460,000,000	0	0	.80%
3-25	D	29,000,000	0	0.5	.77%
3-25	D	26,250,000	0	0	.78%
3-25	D	31,750,000	0.5	1.5	.80%
3-28	C	88,500,000	0	0	.705%
3-28	C	250,000,000	0	2.5	.785%
4-2	F	40,000,000	18.5	1	.88%
4-2	F	102,000,000	0	0	.85%
4-2	H	87,000,000	7	0	.89%
4-20	K	168,000,000	0	0	.80%
4-20	K	375,000,000	0	0	.78%
4-28	C	650,000,000	0	0	.82%
4-28	C	36,500,000	1.5	2.5	.85%

[1] Counts are the averages of two plates and are the number of organisms found in one cubic centimeter

* Mother starter

Table IV. Butter Made from Unpasteurized Cream.[1]

Date	Total Counts		Yeasts and Molds		Per cent Decrease in Butter from Raw Cream	
	Raw Cream	Butter	Raw Cream	Butter	Total Counts	Yeasts & Molds
*11-27	58,500,000	1,662,000	37,000	32,500	97.14	12.16
*11-27	58,500,000	4,100,000	37,000	24,000	92.99	33.78
12-4	210,000	113,500	650	170	45.95	73.84
12-28	53,200,000	1,800,000	22,000	3,500	96.61	84.09
12-30	90,000,000	41,000,000	74,000	7,000	54.44	90.54
12-30	36,500,000	3,900,000	35,500	5,300	89.31	85.07
5-9	22,000,000	22,000,000	550	100	90.00	81.81
5-9	89,000,000	89,000,000	4,550	251	91.84	94.48

[1] Counts are the averages of two or three plates and are the number in one cubic centimeter

* Same lot of cream divided and churned in two types of churns

V. Discussion of Results.

As the results indicate (Table I), the total count and the yeast and mold content may be reduced to a small number in the cream by pasteurization, whereas the butter may show an increase. This tends to show that the yeast and mold count in the finished butter can not be taken as an absolute index for efficiency in pasteurization of raw cream. The actual increase is due, no doubt, to the contamination in the subsequent handling of the cream.

If the yeast and mold count in butter can not be taken as an index to efficiency in pasteurization of raw cream, can it be considered as an efficiency index to the entire butter making process? The data points to the fact that it can be considered as such if we adopt a maximum count of 30 (the standard set by Mr. F. W. Bouska) yeast and mold colonies as efficient. In table I, there are a few cases of a higher count than 30 in the finished butter. When the maximum is passed, the cause of the high count in the ripened cream can be traced to the starter as one source. There is a possibility of the increase being due to unsterile apparatus, and especially to yeast and mold infected churns.

The results in table I indicate that a large percentage of the counts in butter show a decrease over the pasteurized cream, yet the ripened cream carries a higher count than either. The buttermilk shows a decided increase over the above counts, and this tends to indicate that a large number of the yeasts and molds are not incorporated in the butter but are washed out in the buttermilk.

The flash method of pasteurization (where a temperature exposure of 185°F. for 30 seconds is used) was found to be 99.9 per cent efficient in killing yeasts and molds. This compares very favorably with the results obtained by Hunziker (3). The percentage of the decrease from raw cream to the finished butter is found in the columns (Table I) following the pasteurization efficiencies. The percentage of decrease in organisms is smaller, as a rule, than it is after pasteurization. This points to the fact that the cream may be efficiently pasteurized and later contaminated.

There is no doubt but that the shurn is a source of contamination for the finished butter. It is a difficult task to rid the churn of yeasts and molds by ordinary methods, i.e. using hot water followed by steam. The churn will harbor these organims in the pores of the wood, boxings, cracks and similar places where treatment is almost impossible.

In table I, it can be seen that the churn is a source of contamination. The total yeast and mold count in the butter and buttermilk minus the count of the ripened cream (previous to being run into the churn) shows an increase. This must be due to the churn either through direct contamination or the breaking up of clumps by agitation. During the chmrning process, the agitation is sufficient to break clumps into several parts, and this is no doubt a factor in causing the large increase in yeast and mold counts in the butter and buttermilk over that in the ripened cream.

In table II, the results show the effect of the churn in yeast and mold contamination. In studying this table, it must be remembered that in this investigation, 20 gallons of rinse water were used in a churn in which ordinarilly 200 gallons of cream were churned. Therefore, if the rinse water shows a count of 10 yeasts and molds per cubic centimeter, it would mean the addition of only one yeast and mold colony per cubic centimeter if 200 gallons of cream were used.

The ripened cream shows an increase of yeasts and molds over the pasteurized cream (Table I). This may have been due to any one or all of four causes: (1) vat contamination; (2) breaking up of colonies by agitation in the vat; (3) increase due to growth or multiplication; and (4) the starter used. Steaming the vat for 30 minutes apparently killed all of the organisms. At least, plates made from water, which was sterilized and used to rinse the vats, did not show a yeast or mold colony. The agitation in the vat is slow and probably has little effect in breaking up clumps of yeasts and molds. Counts made upon cream before and after agitation confirmed this opinion. After pasteurization was completed

and the starter was added, the cream was cooled to 45°F. to 50°F. (depending on the season of the year) and held over night. The tendency of such a low temperature would be to inhibit multiplication of all organisms.

At first, the starter was thought to be the main source of contamination. However, the average starter is low in yeast and mold content (Table III) and plays a rather unimportant part when we consider that ordinarilly only 10 per cent of starter (20 gallons in 200 gallons of ripendd cream) was used in the plant where this investigation was carried out. For example, if 20 gallons of starter contained 20 yeast and mold colonies per cubic centimeter, when diluted to 200 gallons with cream, it would mean and addition of one colony per cubic centimeter in the cream. None of the starters plated (Table III) contained as many as 20 yeast and mold colonies per cubic centimeter and eleven contained none. This tends to show that the starter may be considered a negligible factor in contamination except in rare cases when an inferior grade of starter is used. In table I (dates, 10-25, 11-23, 3-4 and 7-21), there are several examples of highly contaminated starter, but the butter in two cases out of the four shown, would come within the standard of 30 yeast and mold colonies per cubic centimeter of butter.

The results in table III show that there is no definite relation between the acidity of the starter and the total count and the yeast and mold content. There may be a high or a low determination of either yeasts and molds or total counts with any definite amount of acidity in the starter. For example, it can be seen that with an acidity of .78 per cent, there is a variation between 26,250,000 organisms in one case and 375,000,000 in another. With the same acidity, the yeasts and molds vary from none to three.

It has been suggested by Mr. Lund that the yeast and mold count be taken as a method for distinguishing pasteurized from unpasteurized cream butter. The results in table I show that cream may be efficiently pasteurized but

later recontaminated. In comparing table I (dates, 10-25 and 6-27) with table IV (dates, 12-4 and 5-9), it is shown that the yeast and mold count can not be used effectively. Table I shows that cream which has been pasteurized effectively may be contaminated later and the result is that the butter carries a high count. In table IV, it is shown that butter which was made from unpasteurized cream had a lower count of yeasts and molds than in some cases of pasteurized cream butter.

VI. Conclusions.

The yeast and mold count of finished butter can not be taken as an efficiency index to pasteurization. However, if a standard of 30 colonies is set as the maximum count of these in the finished butter, it can be considered as an efficiency index to the entire butter making process.

The churn may be one of the greatest sources of contamination of the cream after pasteurization.

The cream may be contaminated when starter is used, but this source of yeasts and molds has little effect on the final count in the butter except in rare cases when an extremely inferior grade of starter is added to the cream.

The data points to the fact that the yeast and mold count can not be taken as an effective method of determining whether butter is made from raw or from pasteurized cream.

VII. Bibliography.

(1) "Studies of the Thermal Death Points of Yeasts" - Miriam W. Dougherty. (A thesis for the degree of Master of Science in Bacteriology from the University of Illinois in June, 1920).

(2) "The Thermal Death Points of Yeasts" - E. P. Wells. Vermont Agricultural Experiment Station bulletin number 203.

(3) "Pasteurization in the Dairy Industry" - O. F. Hunziker. The Creamery and Milk Plant Monthly, Volume IV, number 10, page 11.

(4) "Yeasts and Molds in Butter" - T. H. Lund. New York Produce Review and American Creamery Journal, Volume 48 (1919) number 6, pages 282, 284, 286.

(5) "Yeasts and Molds - Influence of the Churn on the Yeast Counts" - T. H. Lund. New York Produce Review and American Creamery Journal, Volume 51 (1921), number 2, page 510.

(6) "Yeasts in Pasteurized Cream" - T. H. Lund. The Creamery and Milk Plant Monthly, January (1921) page 30.

(7) "Yeasts and Mold Counts of Ontario Creamery Butter" - T. H. Lund. (A phamphlet from the bacteriological laboratories of the Ontario Agricultural College, Guelph, Ontario, Canada).

(8) "Yeasts in Pasteurized Cream Butter and Some Suggestions as to Their Probable Source" - T. H. Lund. Abstracts Bacteriology (1921) number 1, page 11.

(9) "The Significance of Yeasts and Molds in Pasteurized Butter" - F. W. Bouska and J. C. Brown. (Article - not published).

(10) "The Effect of Pasteurization on Mold Spores" - Chas. Thom and S. H. Ayers. Journal of Agricultural Research, Volume VI, page 163.